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Okada et al.

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(54) **STEERING-BRACKET SUPPORTING APPARATUS AND STEERING APPARATUS**

USPC 280/777; 248/548
See application file for complete search history.

(71) Applicant: **NSK LTD.**, Tokyo (JP)

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(72) Inventors: **Shinji Okada**, Gunma (JP); **Yuuichi Tomaru**, Gunma (JP)

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(73) Assignee: **NSK LTD.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(21) Appl. No.: **14/894,639**

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(2) Date: **Nov. 30, 2015**

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(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(51) **Int. Cl.**
B62D 1/00 (2006.01)
B62D 1/19 (2006.01)
F16M 13/02 (2006.01)

(57) **ABSTRACT**

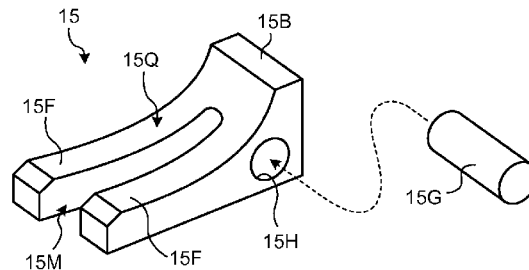
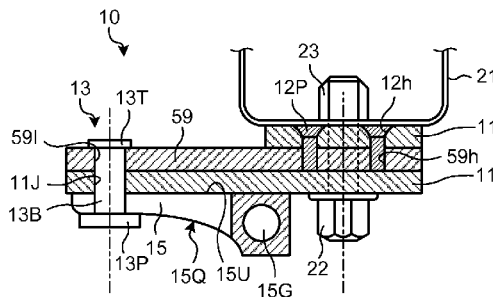
(52) **U.S. Cl.**
CPC **B62D 1/195** (2013.01); **F16M 13/02** (2013.01)

A supporting apparatus for a steering bracket includes a capsule support portion of a steering bracket supporting a steering column, a separation capsule to fix a vehicle body-side member to the steering bracket, a resin member, a shear pin, and an inertial action body including a weight portion moving to a front side of a vehicle by inertia due to a primary collision and pulling out the shear pin from a second bracket-side hole with the movement.

(58) **Field of Classification Search**

CPC B62D 1/195; F16M 13/02

7 Claims, 13 Drawing Sheets



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FIG. 1

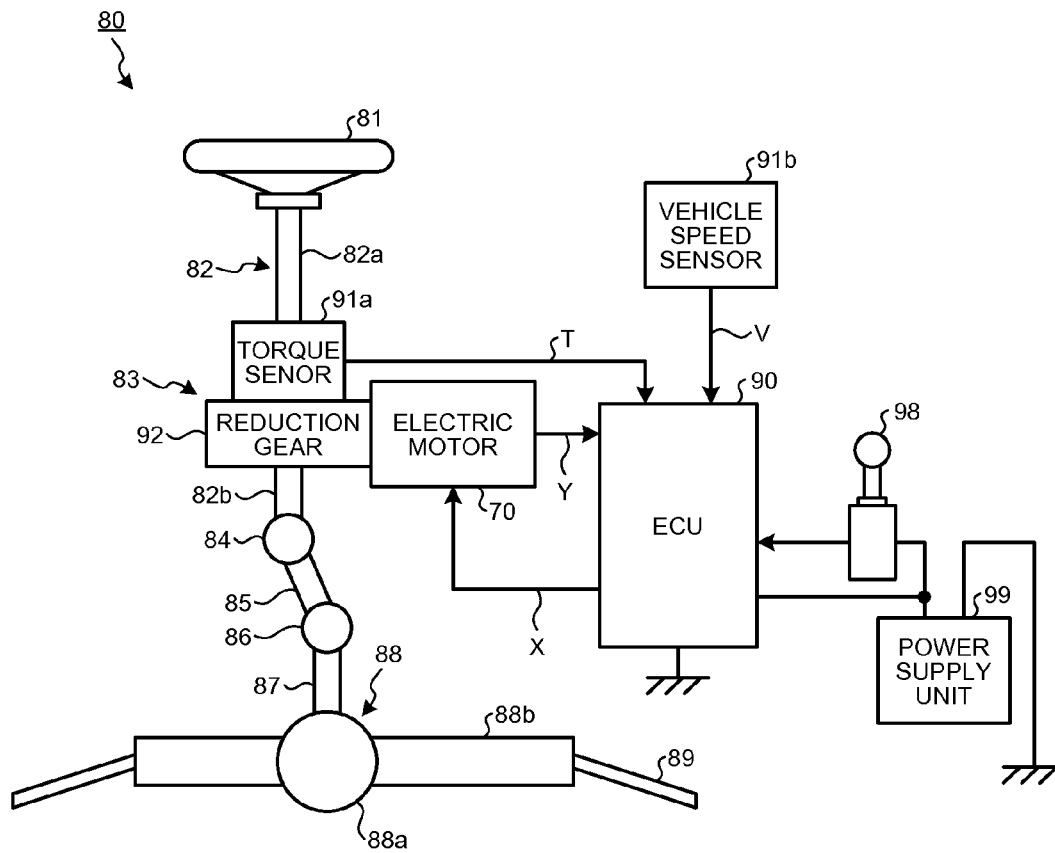


FIG.2

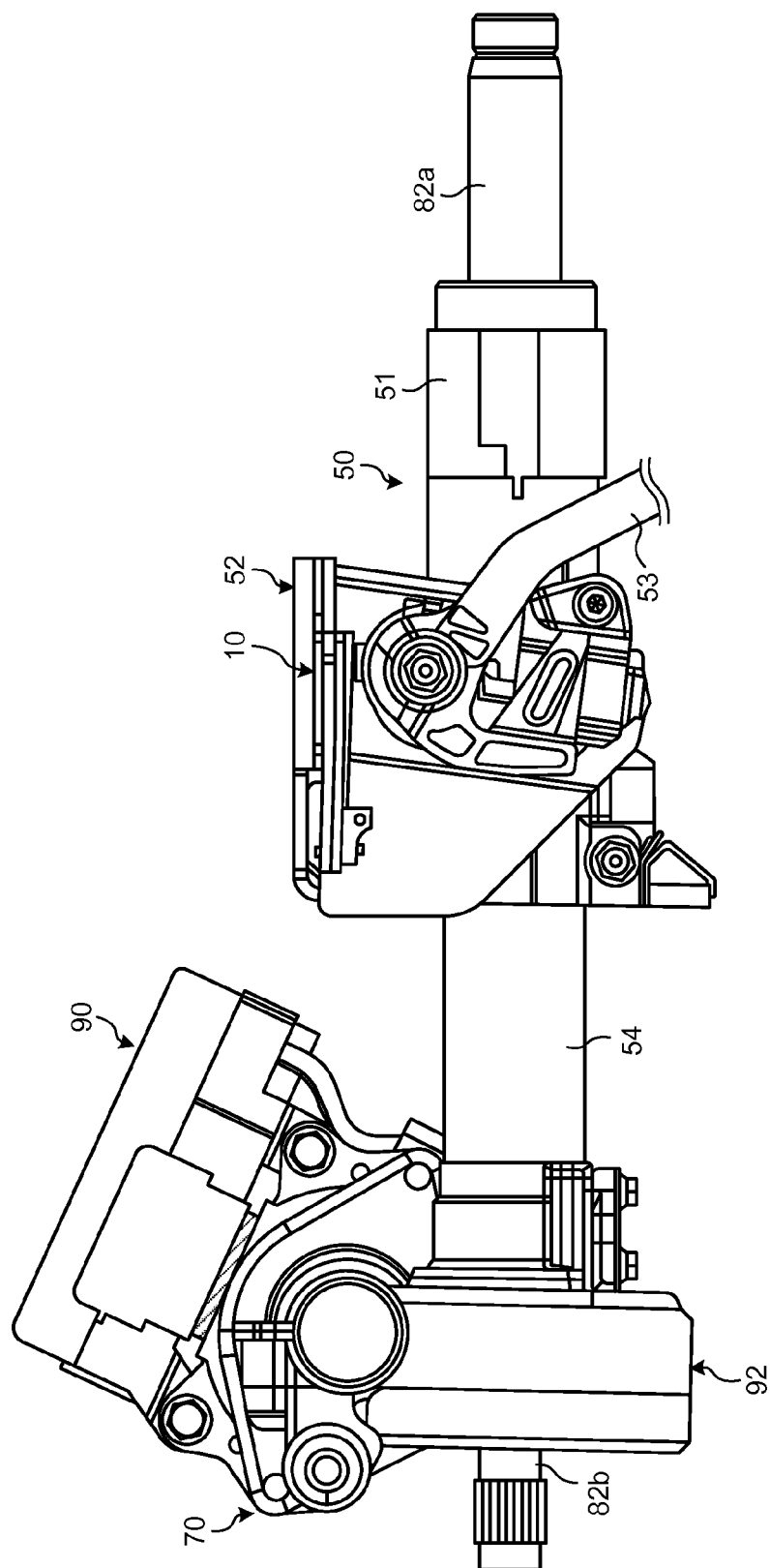


FIG.3

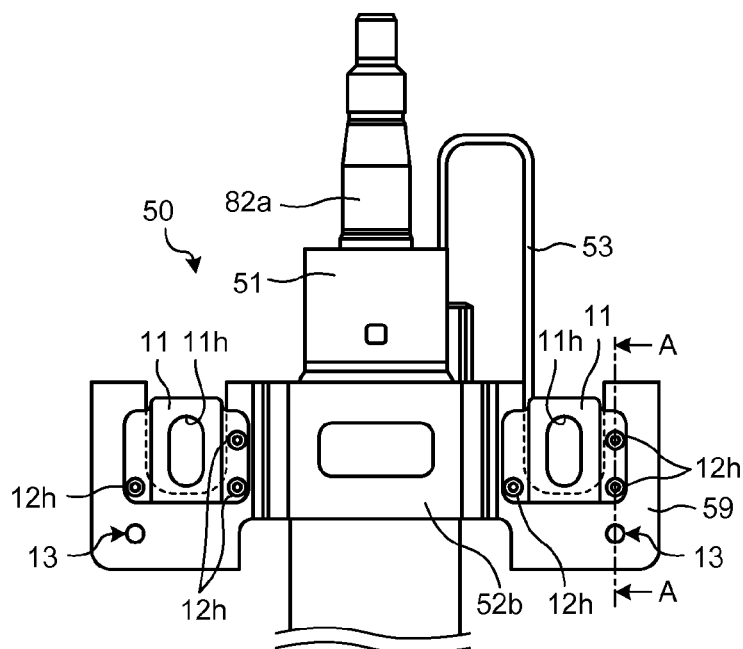


FIG.4

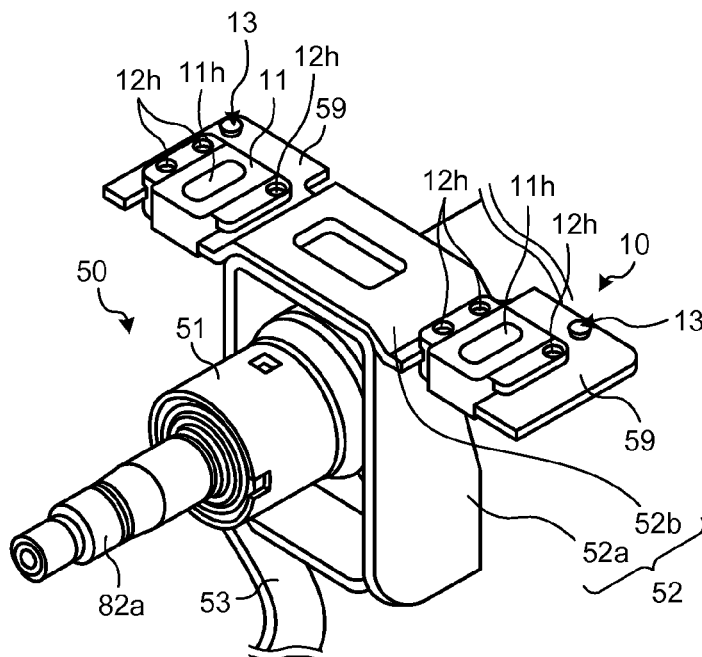


FIG.5

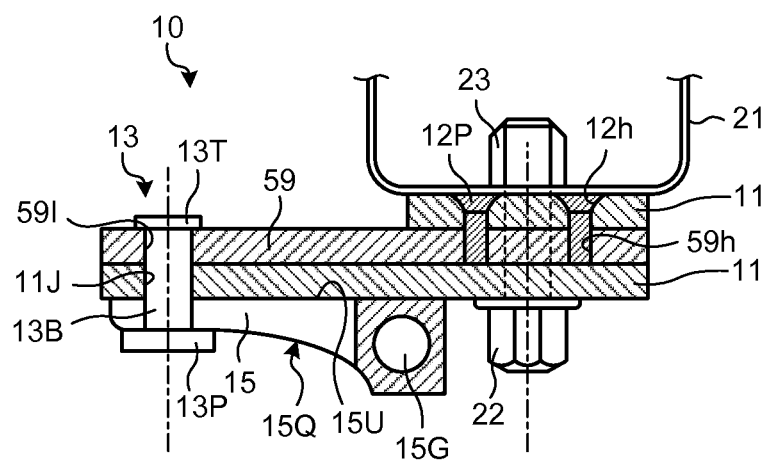


FIG.6

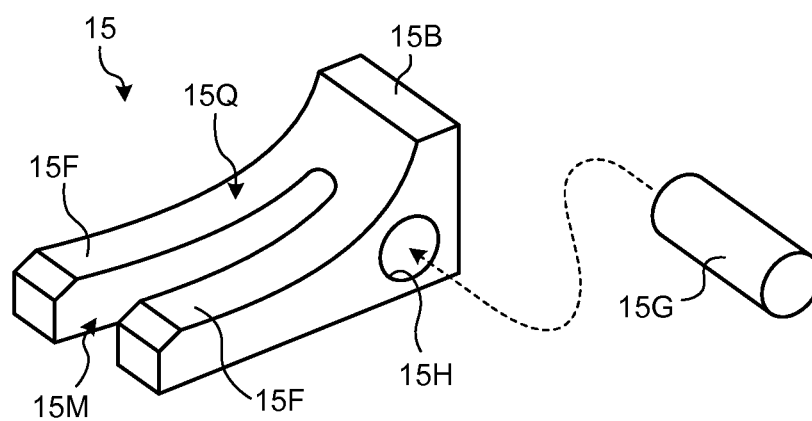


FIG.7

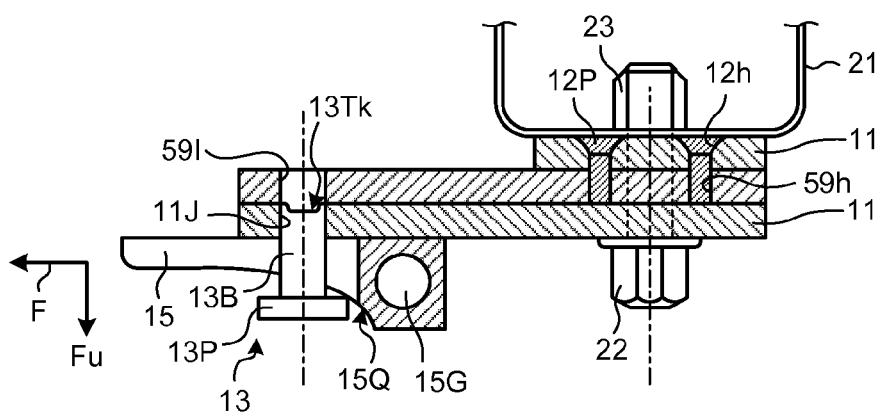


FIG.8

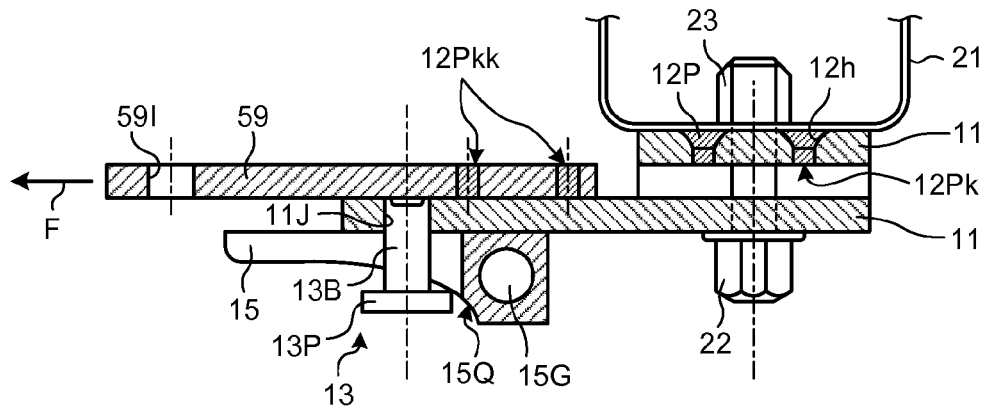


FIG.9

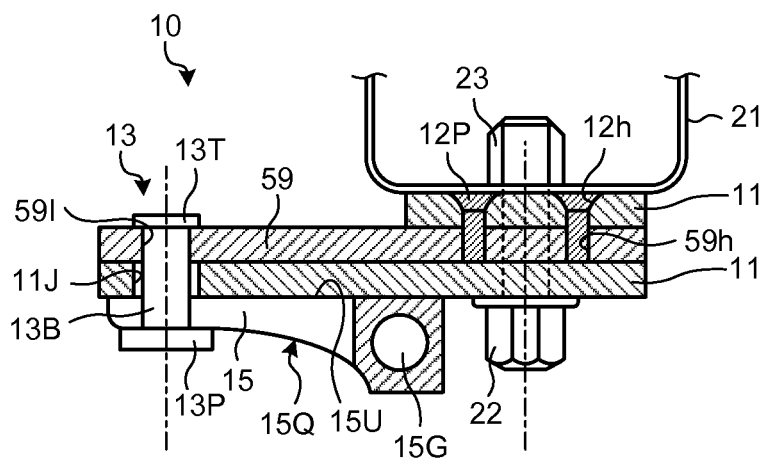


FIG.10

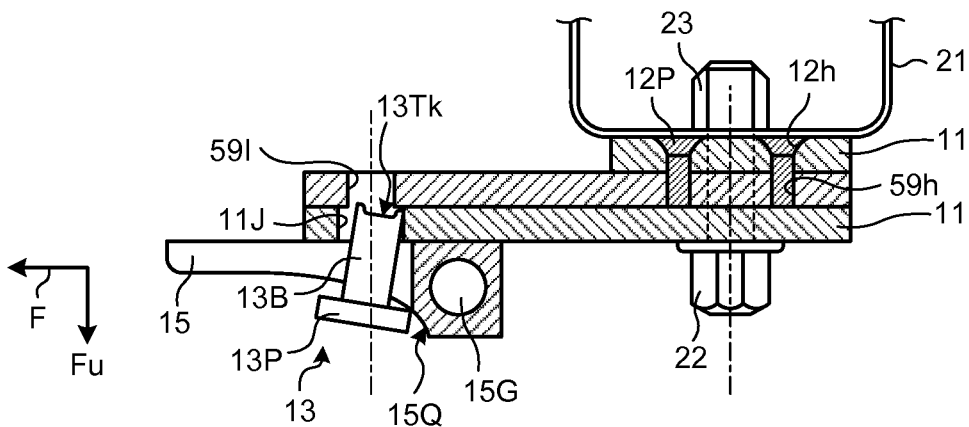


FIG.11

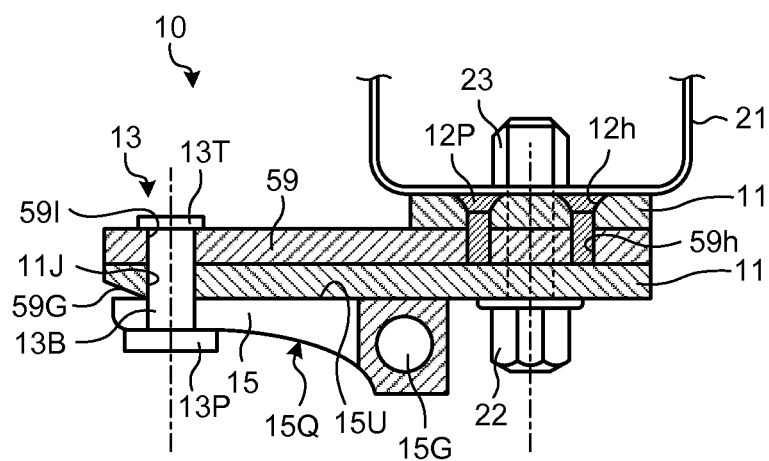


FIG.12

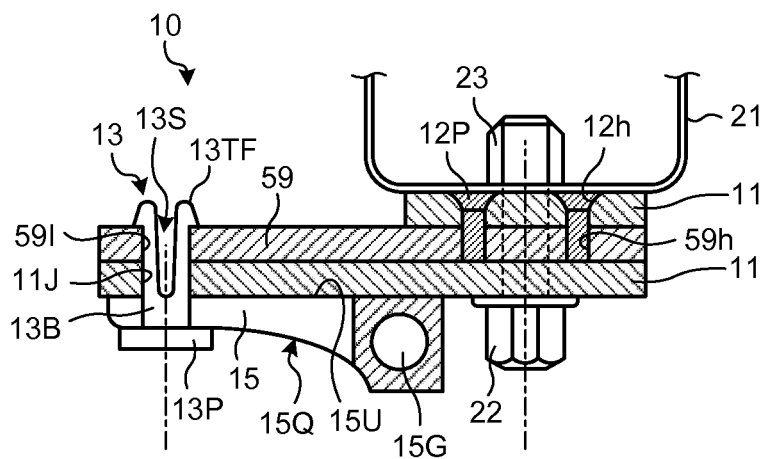


FIG. 13

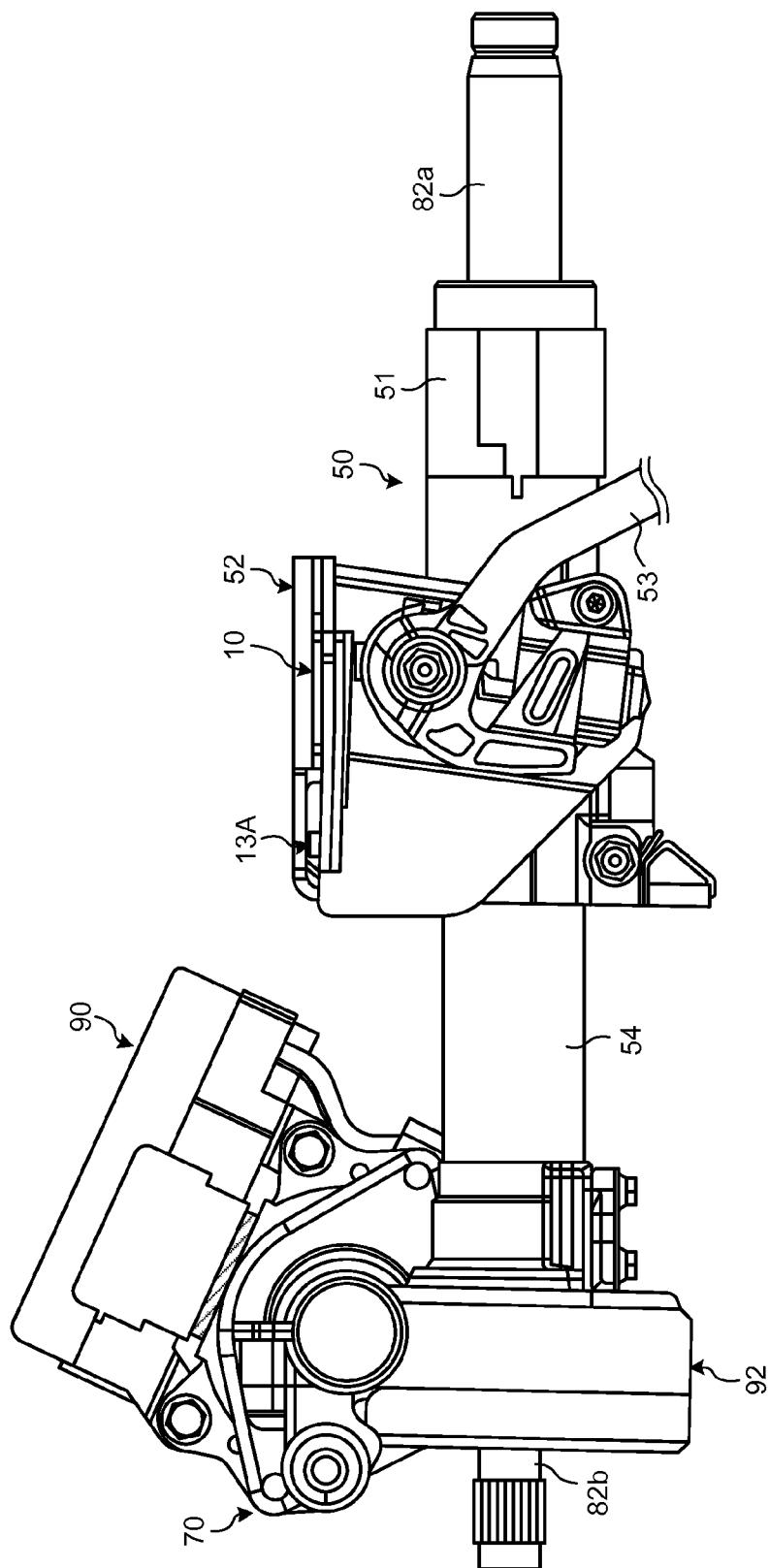


FIG.14

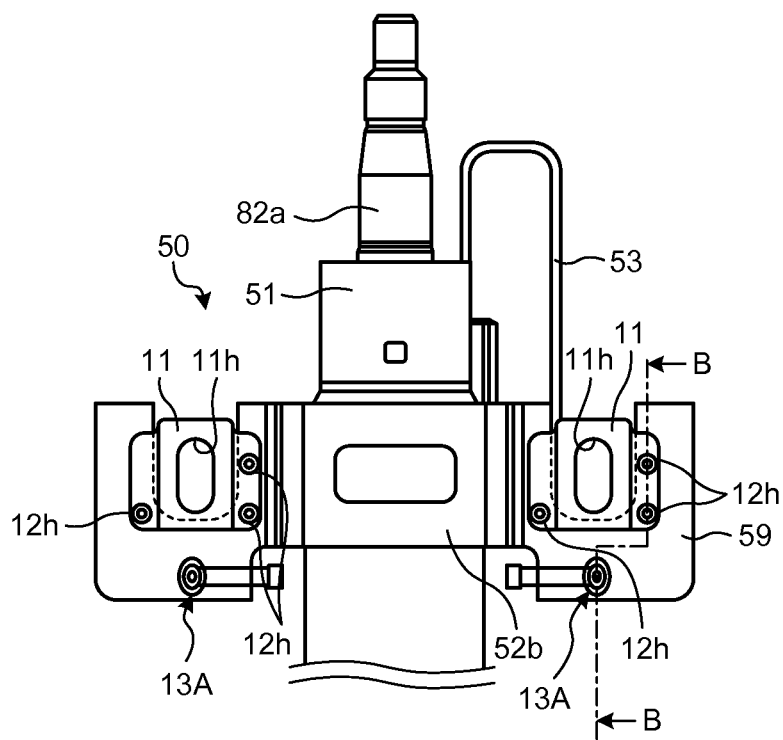


FIG.15

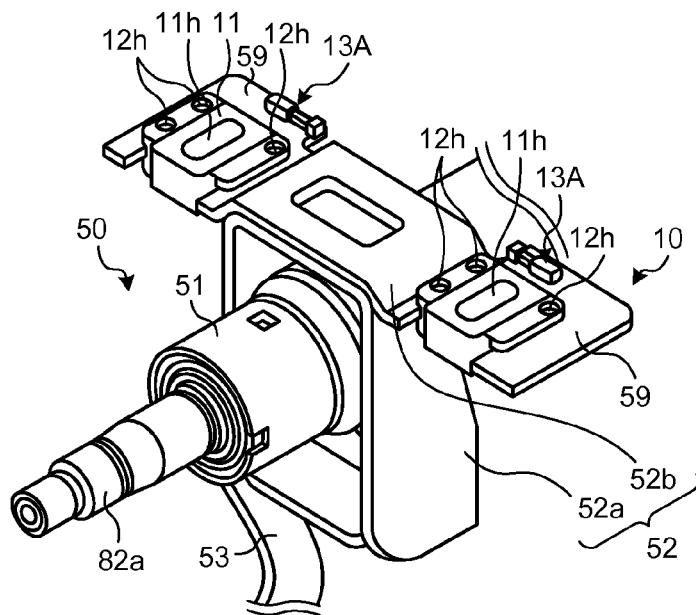


FIG.16

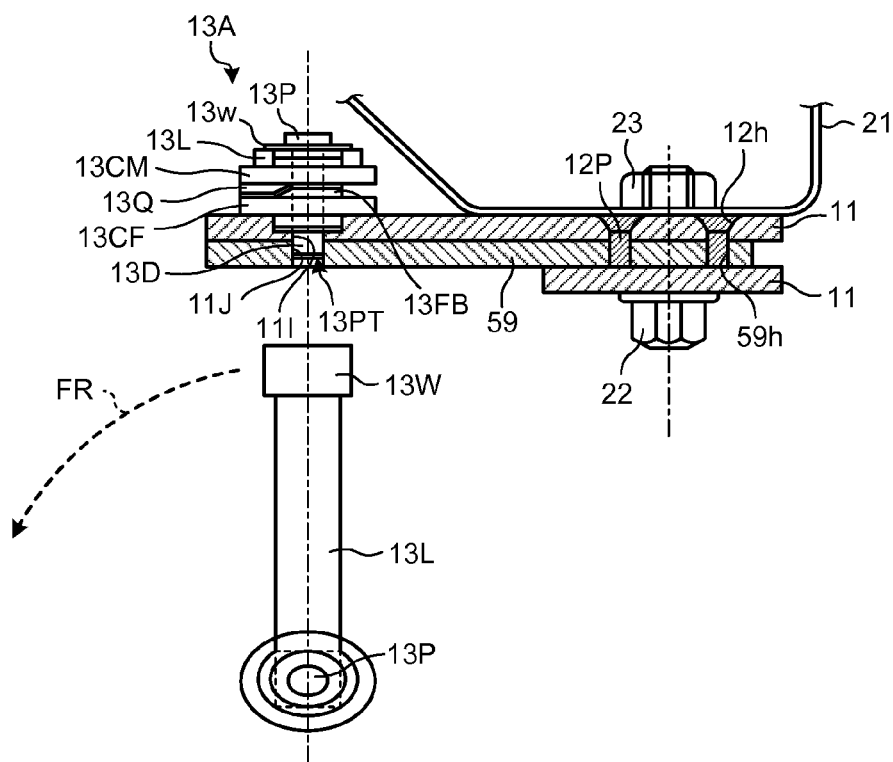


FIG.17

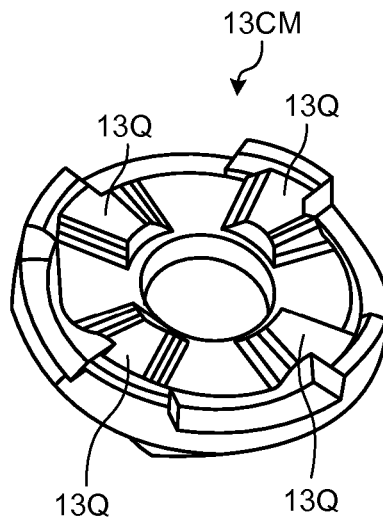


FIG.18

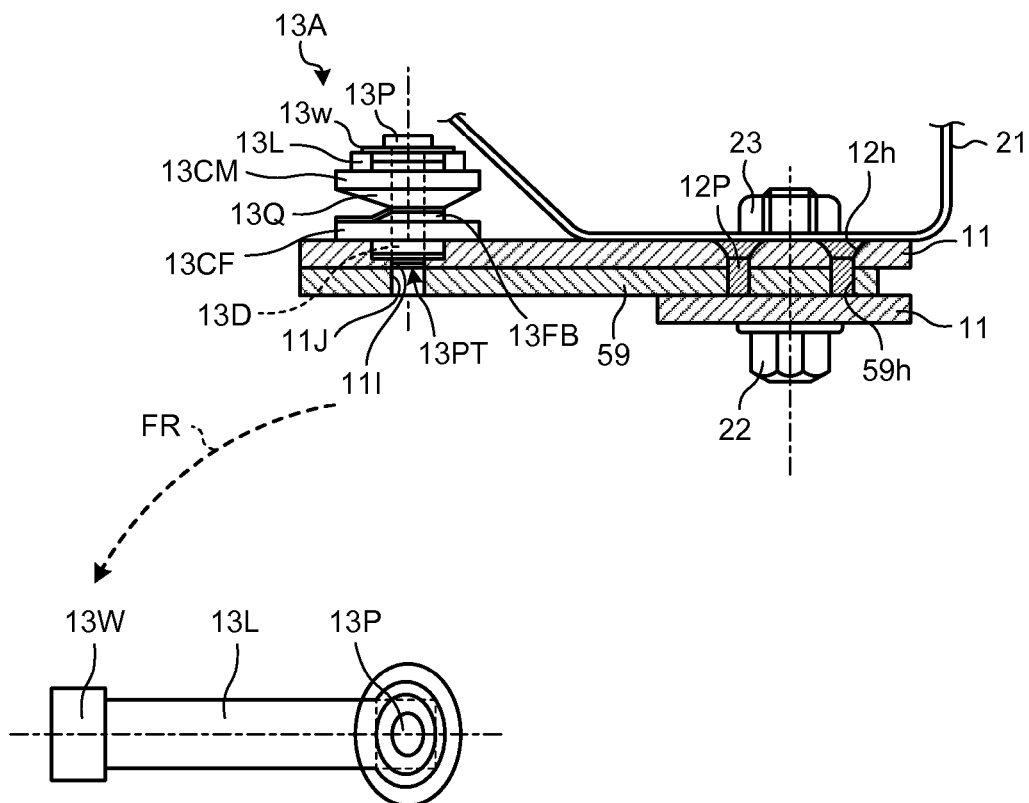


FIG.19

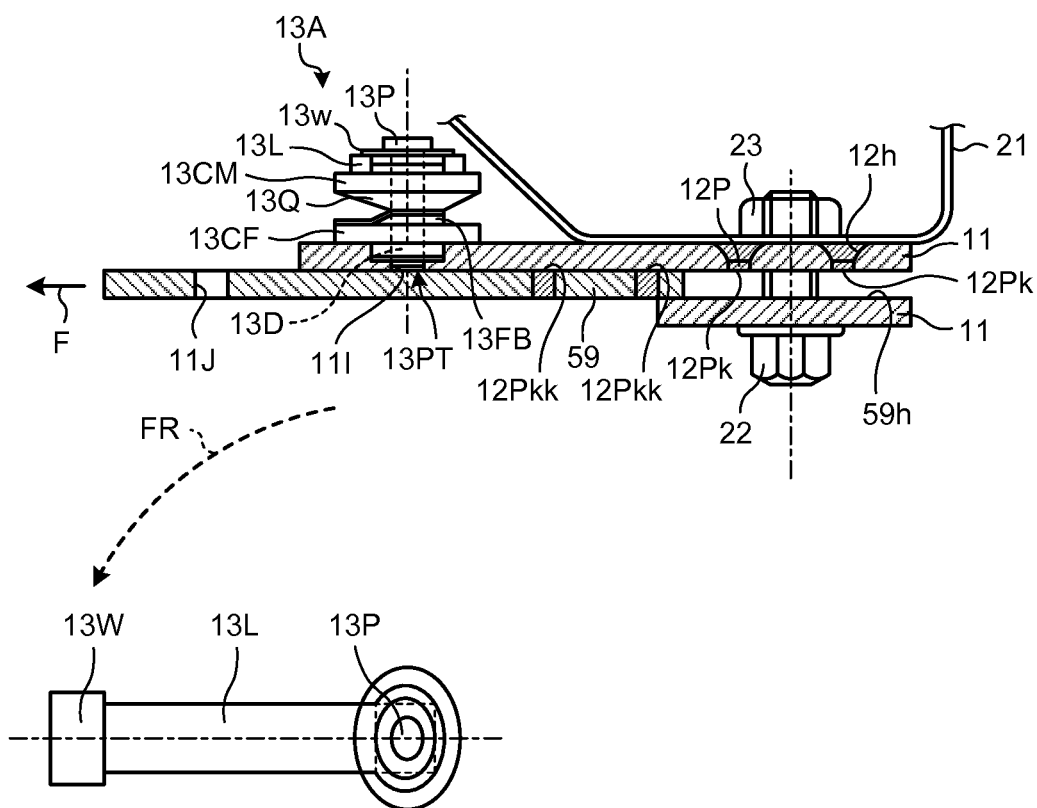


FIG.20

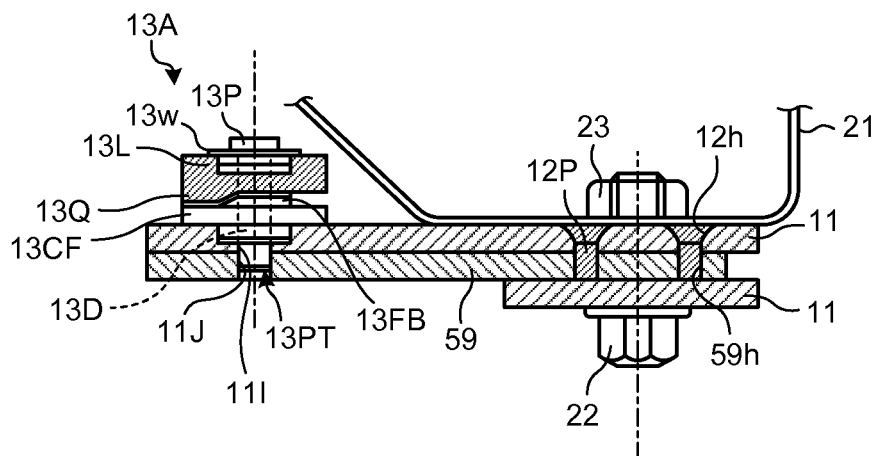


FIG.21

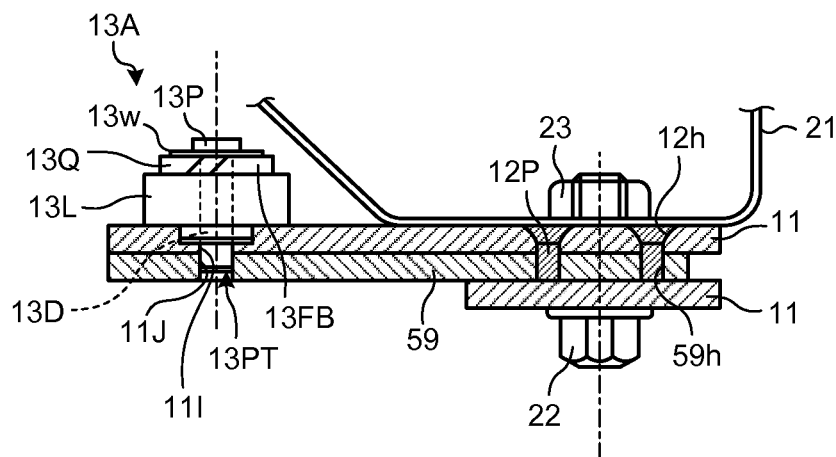
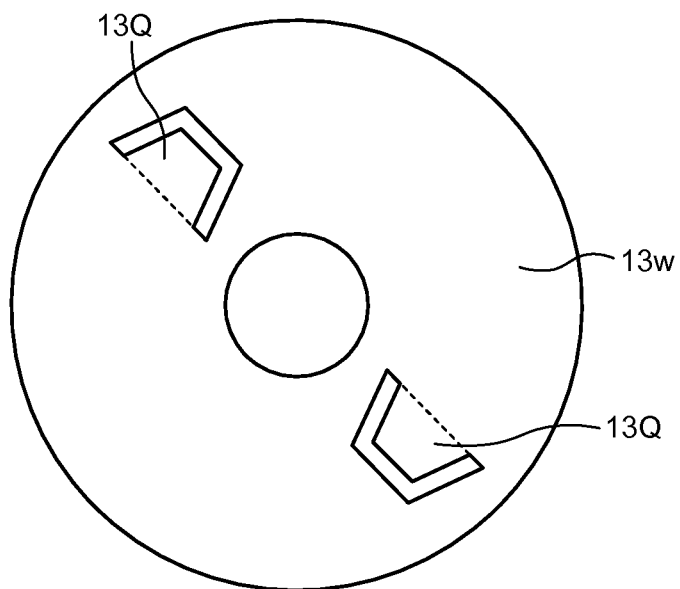


FIG.22



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STEERING-BRACKET SUPPORTING APPARATUS AND STEERING APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a National Stage of International Application No. PCT/JP2014/080388 filed Nov. 17, 2014, claiming priority based on Japanese Patent Application Nos. 2013-240259, filed Nov. 20, 2013, and 2013-240260, filed Nov. 20, 2013, the contents of all of which are incorporated herein by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a steering-bracket supporting apparatus, i.e. a supporting apparatus for fixing a steering bracket to a vehicle body and also relates to a steering apparatus.

2. Description of the Related Art

Prior Art 1 and 2 disclose techniques of a separation capsule in which when an excessive load is applied to a steering column attached to a vehicle and the steering column is pushed to the front of the vehicle, a part of the supporting structure is separated and the steering column thus moves to the front of the vehicle, thereby protecting a driver (operator) from a thrust (secondary collision) of a steering wheel.

PRIOR ART

Prior Art 1: JP 63-019467 U1

Prior Art 2: JP 07-081586 A

In the techniques disclosed in the Prior Art 1 and 2, since a set value of the separation load at which the steering column moves to the front of the vehicle is lowered by cutting a part of the supporting structure, there is a possibility of occurrence in malfunction, in a case of trying to protect an operator who is light in weight.

The present invention has been made in view of the above problem. An object of the present invention is to provide a steering-bracket supporting apparatus and a steering apparatus which are capable of suppressing the malfunction in an ordinary use even when a part of the supporting structure is separated and thus the set value of the separation load at which the steering column moves to the front of the vehicle.

SUMMARY OF THE INVENTION

It is an object of the present invention to at least partially solve the problems in the conventional technology. According to an aspect of the invention, a supporting apparatus for a steering bracket includes, a steering bracket supporting a steering column, the steering bracket including a first capsule-side hole and a second capsule-side hole opened thereon; a separation capsule to fix a vehicle body-side member to the steering bracket, the separation capsule including a first bracket-side hole and a second bracket-side hole opened thereon; a resin member arranged at a position straddling the first bracket-side hole and the first capsule-side hole; a shear pin arranged at a position straddling the second bracket-side hole and the second capsule-side hole; and an inertial action body including a weight portion, the weight portion arranged to move to a front side of a vehicle by inertia due to a primary collision and the inertial action body arranged to pull out the shear pin from the second

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bracket-side hole with a movement of the weight portion. The inertial action body includes a base portion and a claw portion obtained by dividing the base portion with a slit, and the shear pin penetrates into the slit so that a head portion of the shear pin comes into contact with a surface of the claw portion.

When a load is applied to the steering column, which is attached to the vehicle, by the impact in the ordinary use, the steering column is pushed to the front side of the vehicle and the resin member is subjected to the shearing force, and the shearing force is similarly applied to the shear pin. Thus, the fracture of the resin member is suppressed and the malfunction is suppressed during the ordinary use. Meanwhile, in the case of the collision (primary collision) of the vehicle, the inertial action body pulls out the shear pin so that a part of the supporting structure is cut and the set value of the separation load at which the steering column moves to the front side of the vehicle is lowered, thereby the supporting apparatus for the steering bracket can alleviate the impact of an operator who is light in weight.

The inertial action body includes a base portion and a claw portion obtained by dividing the base portion with a slit, and the shear pin penetrates into the slit and a head portion of the shear pin comes into contact with a surface of the claw portion. The inertial action body is clamped between the head portion of the shear pin and the surface of the separation capsule or the steering bracket, and the sliding contact surface of the inertial action body is firmly adhered to the surface of the separation capsule or the steering bracket. Therefore, frictional force is generated between the sliding contact surface of the inertial action body and the surface of the separation capsule or the steering bracket, so that the movement of the inertial action body is set to be suppressed for a relatively weak impact.

As a desirable aspect of the invention, the claw portion is formed such that the distance from a surface of the separation capsule to the surface of the claw portion with which the head of the shear pin comes into contact increases toward the base portion. Thus, the inertial action body can convert a movement into a motion in which the shear pin is pulled out from the second bracket-side hole depending on the movement amount due to the action of inertia.

As a desirable aspect of the invention, the weight portion causes the center of gravity of the inertial action body to be biased to the base portion. Thus, it is possible to set a set value of an operation load in which the inertial action body moves.

As a desirable aspect of the invention, the shear pin includes a hook portion provided at the other end of the head portion and positioned at an edge of the second bracket-side hole or the second capsule-side hole. Since the hook portion is fractured or the hook portion is deformed, the shear pin can be pulled into the second bracket-side hole or the second capsule-side hole, and hence the shear pin is pulled out from the second bracket-side hole with the movement of the inertial action body.

As a desirable aspect of the invention, one of the second bracket-side hole and the second capsule-side hole located near the head portion of the shear pin has a larger diameter than the other. Thus, it is possible to improve the possibility of pulling out the shear pin even when the posture of the shear pin is inclined.

As a desirable aspect of the invention, a guide surface is provided on the surface of the separation capsule or the steering bracket so as to guide a movement direction of an inertial action body **15** due to action of inertia. Even when a moment load including a rotational component is applied

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to the inertial action body, the shear pin can be pulled out along the guide surface by the inertial action body.

As a desirable aspect of the invention, a steering apparatus is supported by the supporting apparatus for the steering bracket. Thus, the steering apparatus can further protect an operator who is light in weight by cutting a part of the supporting structure to lower the set value of the separation load at which the steering column moves to the front side of the vehicle.

According to the present invention, it is possible to provide a steering-bracket supporting apparatus and a steering apparatus which can suppress the malfunction in an ordinary use even when a part of the supporting structure is cut and thus the set value of the separation load at which a steering column moves to the front of the vehicle is lowered.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a constitution diagram of an electric power steering apparatus provided with an electric motor according to a first embodiment.

FIG. 2 is a side view schematically illustrating a periphery of a steering column.

FIG. 3 is a plan view schematically illustrating a supporting apparatus for a steering bracket that is used to attach a steering column to a vehicle.

FIG. 4 is a perspective view schematically illustrating a portion in which the steering column is attached to the vehicle.

FIG. 5 is a schematic cross-sectional view illustrating a state before the supporting apparatus for the steering bracket according to the first embodiment is separated.

FIG. 6 is a perspective view schematically illustrating an inertial action body according to the first embodiment.

FIG. 7 is a schematic cross-sectional view illustrating a state where the shear pin is pulled out in the supporting apparatus for the steering bracket according to the first embodiment.

FIG. 8 is a schematic cross-sectional view illustrating a state after the supporting apparatus for the steering bracket according to the first embodiment is separated.

FIG. 9 is a schematic cross-sectional view illustrating a state before a supporting apparatus for a steering bracket according to a second embodiment is separated.

FIG. 10 is a schematic cross-sectional view illustrating a state where a shear pin of the supporting apparatus for the steering bracket according to the second embodiment is pulled out.

FIG. 11 is a schematic cross-sectional view illustrating a state before a supporting apparatus for a steering bracket according to a third embodiment is separated.

FIG. 12 is a schematic cross-sectional view illustrating a state before a supporting apparatus for a steering bracket according to a fourth embodiment is separated.

FIG. 13 is a plan view schematically illustrating a supporting apparatus for a steering bracket to attach a steering column to a vehicle.

FIG. 14 is a perspective view schematically illustrating a portion where the steering column is attached to the vehicle.

FIG. 15 is a perspective view schematically illustrating a portion where a steering column according to a fifth embodiment is attached to the vehicle.

FIG. 16 is a schematic cross-sectional view illustrating a state before a supporting apparatus for a steering bracket according to the fifth embodiment is separated.

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FIG. 17 is a perspective view schematically illustrating protrusion portions of a cam rotor of a cam mechanism according to the fifth embodiment.

FIG. 18 is a schematic cross-sectional view illustrating a state a shear pin of the supporting apparatus for the steering bracket according to the fifth embodiment is pulled out.

FIG. 19 is a schematic cross-sectional view illustrating a state after the supporting apparatus for the steering bracket according to the fifth embodiment is separated.

FIG. 20 is a schematic cross-sectional view illustrating a state before a supporting apparatus for a steering bracket according to a sixth embodiment is separated.

FIG. 21 is a schematic cross-sectional view illustrating a state before a supporting apparatus for a steering bracket according to a seventh embodiment is separated.

FIG. 22 is a schematic diagram of a washer of the supporting apparatus for the steering bracket according to the seventh embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Embodiments of the present invention will be described in detail with reference to the drawings. The present invention is not limited by the contents described in the following embodiments. In addition, elements described below include those that are easily conceived by a person skilled in the art and that are substantially the same. Further, the elements described below can be properly combined.

First Embodiment

FIG. 1 is a constitution diagram of an electric power steering apparatus provided with an electric motor according to a first embodiment. FIG. 2 is a side view schematically illustrating a periphery of a steering column. FIG. 3 is a plan view schematically illustrating a supporting apparatus for a steering bracket that is used to attach a steering column to a vehicle. FIG. 4 is a perspective view schematically illustrating a portion in which the steering column is attached to the vehicle. FIG. 5 is a schematic cross-sectional view illustrating a state before the supporting apparatus for the steering bracket according to the first embodiment is separated. FIG. 5 is a cross-sectional view taken along the line A-A direction of FIG. 3. The outline of an electric power steering apparatus 80 will be described with reference to FIGS. 1 to 5. In the following description, a front of the vehicle when the electric power steering apparatus 80 is attached to the vehicle is simply described as a front and a rear of the vehicle when the electric power steering apparatus 80 is attached to the vehicle is simply described as a rear.

<Electric Power Steering Apparatus>

In the order in which a force is transmitted by a driver (operator), the electric power steering apparatus 80 includes a steering wheel 81, a steering shaft 82, a steering force assisting mechanism 83, an universal joint 84, a lower shaft 85, an universal joint 86, a pinion shaft 87, a steering gear 88, and a tie rod 89. In addition, the electric power steering apparatus 80 includes an ECU (Electronic Control Unit) 90 and a torque sensor 91a. A vehicle speed sensor 91b is provided in the vehicle and inputs a vehicle speed signal V to the ECU 90 using a CAN (Controller Area Network) communication.

The steering shaft 82 includes an input shaft 82a and an output shaft 82b. One end of the input shaft 82a is connected to the steering wheel 81 and the other end thereof is

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connected to the steering force assisting mechanism **83** through the torque sensor **91a**. One end of the output shaft **82b** is connected to the steering force assisting mechanism **83** and the other end thereof is connected to the universal joint **84**. In this embodiment, the input shaft **82a** and the output shaft **82b** are formed of a magnetic material such as iron.

One end of the lower shaft **85** is connected to the universal joint **84** and the other end thereof is connected to the universal joint **86**. One end of the pinion shaft **87** is connected to the universal joint **86** and the other end thereof is connected to the steering gear **88**.

The steering gear **88** includes a pinion **88a** and a rack **88b**. The pinion **88a** is connected to the pinion shaft **87**. The rack **88b** is engaged with the pinion **88a**. The steering gear **88** is constituted as a rack-and-pinion type. The steering gear **88** converts a rotational motion transmitted to the pinion **88a** into a linear motion with the rack **88b**. The tie rod **89** is connected to the rack **88b**.

The steering force assisting mechanism **83** includes a reduction gear **92** and an electric motor (motor) **70**. Further, the electric motor **70** is a so-called brushless motor which is described as an example, but the electric motor **70** may be an electric motor provided with a brush (slider) and a commutator. The reduction gear **92** is connected to the output shaft **82b**. The electric motor **70** is an electric motor connected to the reduction gear **92** and for generating auxiliary steering torque. In the electric power steering apparatus **80**, the steering shaft **82**, the torque sensor **91a**, and the reduction gear **92** form a steering column. The electric motor configured **70** provides the auxiliary steering torque to the output shaft **82b** of the steering column. That is, the electric power steering apparatus **80** according to this embodiment is a column assist system.

As illustrated in FIG. 2, the steering force assisting mechanism **83** of the electric power steering apparatus **80** includes a steering column **50** and a steering bracket **52**, referred to as an upper attachment bracket functions, as a mechanism for supporting each parts such as the ECU **90** and the electric motor **70**. The steering column **50** rotatably supports the input shaft **82a**. The steering column **50** has a double tube structure constituted by an outer column **51** and an inner column **54** which absorb impact energy at the time of collapse and secure a predetermined collapse contract at a coupling portion to the reduction gear **92**.

The steering bracket **52** is disposed on an upper side of the outer column **51** in a vertical direction. The steering bracket **52** is attached to a vehicle body and supports the outer column **51**. The steering bracket **52** includes an attachment plate portion **52b**, a frame-shaped support portion **52a** formed integrally with the attachment plate portion **52b**, and a tilt mechanism constituted to support the outer column **51**. The attachment plate portion **52b** of the steering bracket **52** is provided with a capsule support portion **59** extending to the outside from the outer column **51**. The tilt mechanism is formed in the frame-shaped support portion **52a**. The steering bracket **52** is fixed to a steering bracket supporting apparatus **10** (hereinafter, referred to as a supporting apparatus **10**) so that the steering bracket **52** is supported by a vehicle body-side member **21** illustrated in FIG. 5.

The supporting state is released by an operation of rotating a tilt lever **53** of the tilt mechanism. By this operation, it is possible to adjust a tilt position of the steering column **50** upward and downward.

The torque sensor **91a** illustrated in FIG. 1 detects a steering force by the driver, transmitted to the input shaft **82a** through the steering wheel **81**, as steering torque. The

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vehicle speed sensor **91b** detects a running speed (vehicle speed) of the vehicle on which the electric power steering apparatus **80** is mounted. The ECU **90** is electrically connected to the electric motor **70**, the torque sensor **91a**, and the vehicle speed sensor **91b**.

<Control Unit: ECU>

The ECU **90** controls the operation of the electric motor **70**. In addition, the ECU **90** acquires a signal from each of the torque sensor **91a** and the vehicle speed sensor **91b**. In other words, the ECU **90** acquires steering torque T from the torque sensor **91a**, and acquires a vehicle speed signal V of the vehicle from the vehicle speed sensor **91b**. Power is supplied to the ECU **90** from a power supply unit (for example, battery on the vehicle) **99** when an ignition switch **98** is turned ON. The ECU **90** calculates an auxiliary steering command value for an assist command, based on the steering torque T and the vehicle speed signal V. Then, the ECU **90** adjusts a power value X to be supplied to the electric motor **70** based on the calculated auxiliary steering command value. From the electric motor **70**, the ECU **90** acquires information of an inductive voltage or rotation information of a rotor such as a resolver to be described below, as operation information Y.

The steering force by a steerer (driver) input to the steering wheel **81** is transmitted to the reduction gear **92** in the steering force assisting mechanism **83** through the input shaft **82a**. At this time, the ECU **90** acquires the steering torque T, which is input to the input shaft **82a**, from the torque sensor **91a** and acquires the vehicle speed signal V from the vehicle speed sensor **91b**. Then, the ECU **90** controls the operation of the electric motor **70**. The auxiliary steering torque generated by the electric motor **70** is transmitted to the reduction gear **92**.

The steering torque (including the auxiliary steering torque) output through the output shaft **82b** is transmitted to the lower shaft **85** through the universal joint **84** and is further transmitted to the pinion shaft **87** through the universal joint **86**. The steering force transmitted to the pinion shaft **87** is transmitted to the tie rod **89** through the steering gear **88**, thereby causing the steering wheel to turn.

(Supporting Apparatus)

A separation capsule **11** illustrated in FIGS. 3 to 5 is formed by aluminum die-casting. The separation capsule **11** is provided with a capsule attachment hole **11h** (see FIGS. 3 and 4) constituted to fix the separation capsule **11** to the vehicle body-side member **21** with a bolt **22** and a nut **23** illustrated in FIG. 5. In addition, the separation capsule **11** has three resin injection holes **12h** (first capsule-side hole) communicated with resin injection holes **59h** (first bracket-side hole) provided at a capsule support portion **59** of the steering bracket **52**, and a resin member **12P** straddles the resin injection hole **59h** and the resin injection hole **12h** in a state before the separation.

The resin member **12P** is a mechanical fuse constituted to be fractured during a secondary collision by shearing force applied to the resin member **12P** which is injected into the resin injection hole **12h** of the separation capsule **11**. A separation load causing the fracture of the resin member **12P** depends on the material and the sheared cross-sectional area of the resin member **12P**. Even when some of the resin member **12P** is cut and thus the set value of the separation load, at which the steering column moves in the front of the vehicle, is lowered, a shear pin **13** according to the first embodiment straddles a second bracket-side hole **59I** and a second capsule-side hole **11J** in the state before the separation so as to withstand impact of, for example, an telescopic operation in an ordinary use. The ordinary use includes a

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condition where inertial or impact is applied due to acceleration and deceleration during a driving operation.

In the ordinary use, when a load is applied to the steering column, which is attached to the vehicle, by the impact of, for example, telescopic operation, if the steering column is pushed to the front of the vehicle, the resin member 12P is subjected to the shearing force and the shearing force is similarly applied to the shear pin 13. Thus, the fracture of the resin member 12P is suppressed and the malfunction is suppressed during the ordinary use.

The shear pin 13 may be made of the same resin as the resin member 12P or be made of a metal. When the shear pin 13 is formed of the resin, the shear pin 13 is fractured simultaneously with the resin member 12P and thus the steering bracket 52 can be separated from the separation capsule 11 fixed to the vehicle body-side member 21 when a considerable load, which an operation of an inertial action body to be described below does not catch up with, is applied in a short time.

As illustrated in FIG. 5, the shear pin 13 includes a cylindrical shear pin body 13B, a head portion 13P which is provided at one end of the shear pin body 13B and has a diameter larger than that of the shear pin body 13B, and a hook portion 13T which is provided at the other end of the shear pin body 13B and is positioned at an edge of the second bracket-side hole 59I of the capsule support portion 59. The hook portion 13T, having the diameter larger than that of the shear pin body 13B and a thickness smaller than that of the head portion 13P, has a fragile structure.

An inertial action body 15 is clamped and fixed between the head portion 13P of the shear pin 13 and the surface of the separation capsule 11. FIG. 6 is a perspective view schematically illustrating the inertial action body according to the first embodiment. As illustrated in FIGS. 5 and 6, the inertial action body 15 has a shape like a head of a nail puller. The inertial action body 15 includes a base portion 15B and two-pronged claw portions 15F and 15F obtained by dividing a part of the base portion 15B with a slit 15M. The claw portions 15F and 15F have an inclined surface or a curved surface such that the distance from the surface of the separation capsule 11 increases toward the base portion 15B. Thus, the inertial action body 15 can convert the inertial action applied thereto to an action to pull out the shear pin 13 from the second bracket-side hole 59I. The shear pin 13 penetrates into the slit 15M, and the head portion 13P comes in contact with a surface 15Q of the claw portion 15F. As a result, as described above, the inertial action body 15 is clamped between the head portion 13P of the shear pin 13 and the surface of the separation capsule 11, and a sliding contact surface 15U of inertial action body 15 is firmly adhered to the separation capsule 11. Therefore, frictional force is generated between the sliding contact surface 15U of the inertial action body 15 and the separation capsule 11, so that the movement of the inertial action body 15 is set to be suppressed for a relatively weak impact.

As illustrated in FIG. 6, in the inertial action body 15, a weight portion 15G is inserted into a hole 15H such that the center of gravity of the inertial action body 15 gathers to the base portion 15B. Thus, it is possible to set a set value of an operation load in which the inertial action body 15 operates. In the first embodiment, the inertial action body 15 is provided with the weight portion 15G separately from the base portion 15B, but may be a weight portion in which the center of gravity of the inertial action body 15 gathers due to the material, the shape, and the like of the base portion 15B. The weight portion 15G biases the center of gravity of the inertial action body 15 toward the base portion 15B.

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As illustrated in FIG. 6, in the inertial action body 15, the base portion 15B and the claw portions 15F are made of an iron material such as stainless steel and the weight portion 15G is made of a material such as tungsten carbide having a larger specific gravity than the base portion 15B.

FIG. 7 is a schematic cross-sectional view illustrating a state where the shear pin is pulled out in the supporting apparatus for the steering bracket according to the first embodiment. For example, when an impact such as a primary collision of the vehicle, which exceeds the set value of the operation load in which the inertial action body 15 operates, is applied to the supporting apparatus 10, the inertial action body 15 moves in a direction F toward the front of the vehicle. The head portion 13P of the shear pin 13 moves along the surface 15Q and the hook portion 13T illustrated in FIG. 5 is broken. Alternatively, the hook portion 13T is deformed to become an end 13Tk to be drawn into the second bracket-side hole 59I and the second capsule-side hole 11J, and is pulled out from the second bracket-side hole 59I as the inertial action body 15 moves. As a result, the shear pin body 13B of the shear pin 13 drops or is pulled out from the second bracket-side hole 59I in a direction Fu as the inertial action body 15 moves. Thus, the weight portion 15G moves to the front of the vehicle by the inertia due to the primary collision, and thus the shear pin 13 can be pulled out from the second bracket-side hole 59I with the movement of the weight portion 15.

FIG. 8 is a schematic cross-sectional view illustrating a state after the supporting apparatus for the steering bracket according to the first embodiment is separated. Subsequently, when an excessive load which exceeds a load set value of the secondary collision is applied to the steering column 50 attached to the vehicle, and the steering column 50 is pushed in the direction F toward the front of the vehicle, a part of the resin member 12P is cut into a resin piece 12Pk and a resin piece 12Pkk. Therefore, the steering column 50 moves to the front of the vehicle to separate the capsule support portion 59 from the separation capsule 11, and the supporting apparatus 10 protects the driver (operator) from a thrust (secondary collision) of a steering wheel.

As described above, the supporting apparatus 10 includes the capsule support portion 59 of the steering bracket 52 supporting the steering column 50, and the separation capsule 11 to fix the vehicle body-side member 21 and the steering bracket 52. The capsule support portion 59 includes the first capsule-side hole 12h and the second capsule-side hole 11J opened thereon, and the separation capsule 11 includes the first bracket-side hole 59h and the second bracket-side hole 59I opened thereon. The resin member 12P is arranged at a position straddling the first bracket-side hole 59h and the first capsule-side hole 12h before the separation. The shear pin 13 is arranged at a position straddling the second bracket-side hole 59I and the second capsule-side hole 11J before the separation. The inertial action body 15 moves separately from the steering column by the action of inertia applied independently to the inertial action body 15 and the shear pin 13 can be pulled out from the second bracket-side hole 59I with the movement of the inertial action body 15.

For this reason, when the load is applied to the steering column 50, which is attached to the vehicle, by the impact in the ordinary use, if the steering column 50 is pushed in the direction F toward the front of the vehicle, the resin member 12P is subjected to the shearing force and the shearing force is similarly applied to the shear pin 13. Thus, the fracture of the resin member 12P is suppressed and the malfunction is suppressed during the ordinary use.

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When the excessive load which exceeds the load set value of the secondary collision is applied to the steering column attached to the vehicle and the steering column 50 is pushed in the Direction F toward the front of the vehicle, the inertial action body 15 moves and the shear pin 13 is pulled out from the second bracket-side hole 59I with the movement of the inertial action body 15. Thereafter, some of the resin member 12P is cut into the resin piece 12Pk and the resin piece 12Pkk, the steering column thus moves to the front of the vehicle to make the state where the capsule support portion 59 is separated from the separation capsule 11, and the supporting apparatus 10 alleviates the impact caused by the collision (secondary collision) of the driver (operator) with the steering wheel. As a result, a part of the supporting structure is cut, which causes lowering of the set value of the separation load at which the steering column 50 moves in the Direction F toward the front of the vehicle, therefore the supporting apparatus 10 can further protect an operator who is light in weight.

The inertial action body 15 according to the first embodiment is fixed to the separation capsule 11 side, but may be fixed to the capsule support portion 59 side. The electric power steering apparatus 80 (steering apparatus) is supported by the supporting apparatus 10 described above. Thus, a part of the supporting structure is cut, which causes lowering of the set value of the separation load at which the steering column 50 moves to the front of the vehicle, therefore the steering apparatus can further protect the operator who is light in weight.

Second Embodiment

FIG. 9 is a schematic cross-sectional view illustrating a state before a supporting apparatus for a steering bracket according to a second embodiment is separated. FIG. 10 is a schematic cross-sectional view illustrating a state a shear pin of the supporting apparatus for the steering bracket according to the second embodiment is pulled out. The same members as those described above are denoted by the same reference numerals and the description thereof will not be presented to avoid duplication. As illustrated in FIGS. 9 and 10, with respect to a second bracket-side hole 59I and a second capsule-side hole 11J, one of the second bracket-side hole 59I and the second capsule-side hole 11J, which is located near the head portion 13P of the shear pin 13, has a larger diameter than the other. For example, the second capsule-side hole 11J has the larger diameter than the second bracket-side hole 59I. Thus, as illustrated in FIG. 9, the second capsule-side hole 11J holds the posture of the shear pin body 13B before the separation. For example, when impact such as a primary collision of the vehicle, which exceeds a set value of an operation load in which an inertial action body 15 operates, is applied to the supporting apparatus 10, the inertial action body 15 moves in a direction F toward a front of a vehicle. The head portion 13P of the shear pin 13 moves along a surface 15Q and a hook portion 13T illustrated in FIG. 9 is broken. Alternatively, the shear pin 13 is deformed to have an end 13Tk, thereby being drawn into the second bracket-side hole 59I and the second capsule-side hole 11J and being pulled out from the second bracket-side hole 59I as the inertial action body 15 moves. As a result, the shear pin body 13B of the shear pin 13 drops or is pulled out from the second bracket-side hole 59I in a direction Fu as the inertial action body 15 moves. In this case, as illustrated in FIG. 10, with respect to the relation between the surface 15Q and the head portion 13P, when the surface 15Q has an inclined surface or a curved surface, the head portion is not

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necessarily pulled out parallel to the direction Fu. As in the second embodiment, when the second capsule-side hole 11J has a larger diameter than the second bracket-side hole 59I, it is possible to increase the probability of the pulling-out even when the posture of the shear pin body 13B is inclined.

Third Embodiment

FIG. 11 is a schematic cross-sectional view illustrating a state before a supporting apparatus for a steering bracket according to a third embodiment is separated. The same members as those described above are denoted by the same reference numerals and the description thereof will not be presented to avoid duplication. As illustrated in FIG. 11, a guide surface 59G is provided on the surface of a capsule support portion 59 or a separation capsule 11 of a steering bracket to guide a movement direction of an inertial action body 15 due to action of inertia. For example, even when a moment load including a rotational component is applied to a weight portion 15G, a shear pin 13 can be pulled out along the guide surface 59G by the inertial action body 15.

Fourth Embodiment

FIG. 12 is a schematic cross-sectional view illustrating a state before a supporting apparatus for a steering bracket according to a fourth embodiment is separated. The same members as those described above are denoted by the same reference numerals and the description thereof will not be presented to avoid duplication. As illustrated in FIG. 12, a shear pin 13 according to the fourth embodiment includes a cylindrical shear pin body 13B, a head portion 13P which is provided at one end of the shear pin body 13B and has a diameter larger than that of the shear pin body 13B, and a hook portion 13TF which is provided at the other end of the shear pin body 13B and is positioned at an edge of a second bracket-side hole 59I of a capsule support portion 59. A hollow portion 13S with a bottom is opened in the shear pin body 13B and elastic force is urged to the outside of a hook portion 13TF. Therefore, the shear pin 13 according to the fourth embodiment is constituted such that the diameter of the hook portion 13TF facilely decreases and it is possible to pull out the shear pin 13 without breakage.

Fifth Embodiment

FIG. 13 is a plan view schematically illustrating a supporting apparatus for a steering bracket constituted to attach a steering column to a vehicle. FIG. 14 is a perspective view schematically illustrating a portion constituted to attach the steering column to the vehicle. FIG. 15 is a perspective view schematically illustrating a portion constituted to attach a steering column according to a fifth embodiment to the vehicle. FIG. 15 is a cross-sectional view as viewed in the line B-B direction of FIG. 13. FIG. 16 is a schematic cross-sectional view illustrating a state before a supporting apparatus for a steering bracket according to the fifth embodiment is separated. The same members as those described above are denoted by the same reference numerals and the description thereof will not be presented to avoid duplication. A separation capsule 11 illustrated in FIGS. 13 to 16 is formed by aluminum die-casting. The separation capsule 11 is provided with a capsule attachment hole 11h (see FIGS. 3 and 15) constituted to fix a separation capsule 11 to a vehicle body-side member 21 with a bolt 22 and a nut 23 illustrated in FIG. 16. In addition, the separation capsule 11 has three resin injection holes 12h (first capsule-side

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hole) communicated with resin injection holes **59h** (first bracket-side hole) provided at a capsule support portion **59** of the steering bracket, and a resin member **12P** straddles the resin injection hole **59h** and the resin injection hole **12h** in a state before the separation.

The resin member **12P** injected into the resin injection hole **12h** of the separation capsule **11** is a mechanical fuse constituted to be fractured by shearing force applied during a secondary collision. A separation load causing the fracture of the resin member **12P** depends on the material and the sheared cross-sectional area of the resin member **12P**. Even when a part of the resin member **12P** is cut causing lowering of the set value of the separation load at which the steering column moves in the front of the vehicle, a shear pin **13D** according to the fifth embodiment straddles a second bracket-side hole **11I** and the second capsule-side hole **11J** in the state before the separation so as to withstand impact of, for example, an telescopic operation in an ordinary use. The ordinary use includes a condition where inertial or impact is applied due to acceleration and deceleration during a driving operation.

When a load is applied to the steering column **50**, which is attached to the vehicle, by the impact of, for example, telescopic operation in the ordinary use, if the steering column **50** is pushed to the front of the vehicle, the resin member **12P** is subjected to the shearing force and the shearing force is similarly applied to the shear pin **13D**. Thus, the fracture of the resin member **12P** is suppressed and the malfunction is suppressed during the ordinary use.

The shear pin **13D** may be made of the same resin as the resin member **12P** and be made of a metal. When the shear pin **13D** is formed of the resin, the shear pin **13D** is fractured simultaneously with the resin member **12P** and thus the steering bracket **52** can be separated from the separation capsule **11** fixed to the vehicle body-side member **21**, when a considerable load is applied in a short time such that an operation of a cam mechanism to be described below does not catch up with the considerable load.

As illustrated in FIG. 16, the shear pin **13D** includes a head portion **13P** which is provided at one end of a shear pin body of solid cylindrical body and has a diameter larger than that of the shear pin body. A pin tip **13PT** which is the other end of the shear pin body of the shear pin **13D** is inserted into the second bracket-side hole **11I** of the capsule support portion **59** in the state before the separation and is positioned in a cam mechanism **13A**. The pin tip **13PT** may be penetrated through the second bracket-side hole **11I**.

The cam mechanism **13A** includes a cam rotor **13CM** interlocking with the shear pin **13D**, and a cam stator **13CF** fixed to the capsule support portion **59** or the separation capsule **11** of the steering bracket. FIG. 17 is a perspective view schematically illustrating protrusion portions of the cam rotor of the cam mechanism according to the fifth embodiment. As illustrated in FIG. 17, the cam rotor **13CM** has protrusion portions **13Q** on a surface facing the cam stator **13CF**. The cam stator **13CF** has protrusion portions **13FB**, which are similar to the protrusion portions **13Q** illustrated in FIG. 17, on a surface facing the cam rotor **13CM**. Since the protrusion portions **13FB** of the cam stator **13CF** are located at recessed portions between the protrusion portions **13Q** of the cam rotor **13CM**, and the protrusion portions **13Q** and the protrusion portions **13FB** have the similar height, the protrusion portions **13Q** and the protrusion portions **13FB** are engaged with each other. When the cam rotor **13CM** rotates relative to the cam stator **13CF**, as illustrated in FIG. 18, the phase of the protrusion portions **13Q** coincides with that of the protrusion portions **13FB**. In

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this case, since the protrusion portions **13Q** ride over the protrusion portions **13FB**, the distance between the cam rotor **13CM** and the cam stator **13CF** increases. The shear pin **13D** penetrates a lever member **13L** to be described below and a washer **13w**, and the head portion **13P** is supported by the washer **13w**. For this reason, the distance between the cam rotor **13CM** and the cam stator **13CF** increases depending on the rotation amount of the cam rotor **13CM** which rotates relative to the cam stator **13CF**. An insertion length of the shear pin **13D** to be inserted into the second bracket-side hole **11I** varies depending on the distance between the cam rotor **13CM** and the cam stator **13CF**. Thus, the cam mechanism **13A** can convert the rotation motion, which depends on the amount of rotation due to the inertial action, to a motion in which the shear pin **13D** is pulled out from the second bracket-side hole **11I**.

The lever member **13L** is a rod-shaped member which rotates interlocking with the rotation of the cam rotor **13CM**. Since the lever member **13L** applies the load to a part of the cam rotor **13CM**, the lever member **13L** is a member which is used to move the center of gravity of the cam rotor toward the outside from a rotation center of the cam rotor **13CM**. Thus, it is possible to set a set value of an operation load in which the cam mechanism **13A** operates. The lever member **13L** is provided with a weight portion **13W** at a side far from the cam rotor **13CM**. The weight portion **13W** is made of a material such as tungsten carbide having a larger specific gravity than the cam rotor **13CM**. This makes it possible to increase the amount of movement of the center of gravity toward the outside from the rotation center of the cam rotor **13CM**. In this way, the weight portion **13W** allows the center of gravity of the lever member **13L** to be biased toward the outside from the rotation center of the cam rotor **13CM**.

As illustrated in FIG. 16, the lever member **13L** is disposed in a direction orthogonal to the front of the vehicle when the surface of the separation capsule **11** is viewed in a plan view. For example, when impact such as a primary collision of the vehicle, which exceeds the set value of the operation load in which the lever member **13L** rotates, is applied to the supporting apparatus **10**, the lever member **13L** of the cam mechanism **13A** rotates in a direction FR toward the front of the vehicle. The distance between the cam rotor **13CM** and the cam stator **13CF** increases depending on the rotation amount of the cam rotor **13CM** which rotates relative to the cam stator **13CF**. The insertion amount of the shear pin **13D** to be inserted into the second bracket-side hole **11I** decreases with the movement of the cam rotor **13CM**. As a result, as illustrated in FIG. 18, the shear pin **13D** is pulled out from the second bracket-side hole **11I** with the movement of the cam rotor **13CM**.

FIG. 19 is a schematic cross-sectional view illustrating a state after the supporting apparatus for the steering bracket according to the fifth embodiment is separated. Subsequently, when an excessive load exceeding a load set value of the secondary collision is applied to the steering column attached to the vehicle and the steering column is pushed to the front of the vehicle, a part of the resin member **12P** is cut into a resin piece **12Pk** and a resin piece **12Pkk**, the steering column moves to the front of the vehicle to make the state where the capsule support portion **59** is separated from the separation capsule **11**, and the supporting apparatus **10** alleviates the impact caused by the collision (secondary collision) of the driver (operator) with the steering wheel.

As described above, the supporting apparatus **10** includes the capsule support portion **59** of the steering bracket **52**, which supports the steering column **50**, and the separation capsule **11** to fix the vehicle body-side member **21** and the

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steering bracket, and the capsule support portion **59** includes the first capsule-side hole **12h** and the second capsule-side hole **11J** opened thereon, and the separation capsule **11** includes the first bracket-side hole **59h** and the second bracket-side hole **11I** opened thereon. The shear pin **13D** is arranged at a position straddling the first bracket-side hole **59h** and the first capsule-side hole **12h** before the separation. The resin member **12P** is arranged at a position straddling the second bracket-side hole **11I** and the second capsule-side hole **11J** before the separation. In the supporting apparatus **10**, the cam mechanism **13A** rotates by the action of inertia. That is, the weight portion **13W** rotates around the shear pin **13D** by the inertia due to the primary collision and moves to the front of the vehicle. The shear pin **13D** can be pulled out from the second bracket-side hole **11I** with the rotation of the cam mechanism **13A**.

For this reason, when the load due to the impact during the ordinary use is applied to the steering column **50** attached to the vehicle, if the steering column **50** is pushed to the front of the vehicle, the resin member **12P** is subjected to the shearing force, and the shearing force is similarly applied to the shear pin **13D**. Thus, the fracture of the resin member **12P** is suppressed and the malfunction is suppressed during the ordinary use.

When the excessive load exceeding the load set value of the secondary collision is applied to the steering column attached to the vehicle and the steering column **50** is pushed in the direction **F** toward the front of the vehicle, since the cam mechanism **13A** rotates by the action of inertia and the shear pin **13D** is pulled out from the second bracket-side hole **11I** with the rotation of the cam mechanism **13A**, a part of the resin member **12P** is cut into the resin piece **12Pk** and the resin piece **12Pkk**, the steering column thus moves to the front of the vehicle to make the state where the capsule support portion **59** is separated from the separation capsule **11**, and the supporting apparatus **10** alleviates the impact caused by the collision (secondary collision) of the driver (operator) with the steering wheel. As a result, a part of the supporting structure is cut, which lowers the set value of the separation load at which the steering column **50** moves in the direction **F** toward the front of the vehicle, so that the supporting apparatus **10** can further protect an operator who is light in weight.

The cam mechanism **13A** according to the fifth embodiment is fixed to the surface of the capsule support portion **59**, but may be fixed to the separation capsule **11** side. An electric power steering apparatus **80** (steering apparatus) is supported by the supporting apparatus **10** described above. Thus, a part of the supporting structure is cut, which lowers the set value of the separation load at which the steering column **50** moves to the front of the vehicle, so that the steering apparatus can further protect the operator who is light in weight.

Sixth Embodiment

FIG. **20** is a schematic cross-sectional view illustrating a state before a supporting apparatus for a steering bracket according to a sixth embodiment is separated. The same members as those described above are denoted by the same reference numerals and the description thereof will not be presented to avoid duplication. As illustrated in FIG. **20**, the function of the cam rotor **13CM** according to the fifth embodiment may be integrated with a lever member **13L**. The lever member **13L** is provided with protrusion portions

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13Q. The lever member **13L** may be integrated with or fixed to a head portion **13P** of a shear pin **13D**.

Seventh Embodiment

FIG. **21** is a schematic cross-sectional view illustrating a state before a supporting apparatus for a steering bracket according to a seventh embodiment is separated. FIG. **22** is a schematic diagram of a washer of the supporting apparatus for the steering bracket according to the seventh embodiment. The same members as those described above are denoted by the same reference numerals and the description thereof will not be presented to avoid duplication. As illustrated in FIG. **21**, the function of the cam rotor **13CM** according to the fifth embodiment may be integrated with a washer **13w**. As illustrated in FIG. **22**, the washer **13w** is provided with protrusion portions **13Q** which are bendable by a slit. The protrusion portions **13Q** are cut and raised, and thus the washer **13w** protrudes toward a protrusion portion **13FB** of the lever member **13L**.

REFERENCE SIGNS LIST

- 10** SUPPORTING APPARATUS
- 11** SEPARATION CAPSULE
- 11h** CAPSULE ATTACHMENT HOLE
- 11J** SECOND CAPSULE-SIDE HOLE
- 12h** RESIN INJECTION HOLE (FIRST CAPSULE-SIDE HOLE)
- 12P** RESIN MEMBER
- 12Pk, 12Pkk** RESIN PIECE
- 13, 13D** SHEAR PIN
- 13A** CAM MECHANISM
- 13B** SHEAR PIN BODY
- 13CF** CAM STATOR
- 13CM** CAM ROTOR
- 13L** LEVER MEMBER
- 13P** HEAD PORTION
- 13PT** PIN TIP
- 13Q** PROTRUSION PORTION
- 13FB** PROTRUSION PORTION
- 13T** HOOK PORTION
- 13TF** HOOK PORTION
- 13S** HOLLOW PORTION
- 13W** WEIGHT PORTION
- 13w** WASHER
- 15** INERTIAL ACTION BODY
- 15M** SLIT
- 15B** BASE PORTION
- 15H** HOLE
- 15G** WEIGHT PORTION
- 15U** SLIDING CONTACT SURFACE
- 15F** CLAW PORTION
- 15Q** SURFACE
- 21** VEHICLE BODY-SIDE MEMBER
- 22** BOLT
- 23** NUT
- 50** STEERING COLUMN
- 51** OUTER COLUMN
- 52** STEERING BRACKET
- 53** TILT LEVER
- 54** INNER COLUMN
- 59** CAPSULE SUPPORT PORTION
- 59h** RESIN INJECTION HOLE (FIRST BRACKET-SIDE HOLE)
- 59I, 11I** SECOND BRACKET-SIDE HOLE
- 70** ELECTRIC MOTOR

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80 ELECTRIC POWER STEERING APPARATUS
81 STEERING WHEEL
82 STEERING SHAFT
82a INPUT SHAFT
82b OUTPUT SHAFT
83 STEERING FORCE ASSISTING MECHANISM
84 UNIVERSAL JOINT
85 LOWER SHAFT
86 UNIVERSAL JOINT
87 PINION SHAFT
88 STEERING GEAR
88a PINION
88b RACK
89 TIE ROD
90 ECU
91a TORQUE SENSOR
91b VEHICLE SPEED SENSOR
92 REDUCTION GEAR
98 IGNITION SWITCH
99 POWER SUPPLY UNIT

The invention claimed is:

1. A supporting apparatus for a steering bracket, comprising:

- a steering bracket supporting a steering column, the steering bracket including a first capsule-side hole and a second capsule-side hole opened thereon;
- a separation capsule to fix a vehicle body-side member to the steering bracket, the separation capsule including a first bracket-side hole and a second bracket-side hole opened thereon;
- a resin member arranged at a position straddling the first bracket-side hole and the first capsule-side hole;
- a shear pin arranged at a position straddling the second bracket-side hole and the second capsule-side hole; and
- an inertial action body including a weight portion, the weight portion arranged to move to a front side of a vehicle by inertia due to a primary collision and the inertial action body arranged to pull out the shear pin

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from the second bracket-side hole with a movement of the weight portion, wherein

the inertial action body includes a base portion and a claw portion obtained by dividing the base portion with a slit, and

the shear pin penetrates into the slit so that a head portion of the shear pin comes into contact with a surface of the claw portion.

2. The supporting apparatus for the steering bracket according to claim 1, wherein the claw portion is formed such that a distance from a surface of the separation capsule to the surface of the claw portion with which the head portion of the shear pin comes into contact increases toward the base portion.

3. The supporting apparatus for the steering bracket according to claim 1, wherein the weight portion causes a center of gravity of the inertial action body to be biased to the base portion.

4. The supporting apparatus for the steering bracket according to claim 1, wherein the shear pin includes a hook portion provided at one end of the head portion and positioned at an edge of the second bracket-side hole or the second capsule-side hole.

5. The supporting apparatus for the steering bracket according to claim 1, wherein one of the second bracket-side hole and the second capsule-side hole located near the head portion of the shear pin has a larger diameter than the other one of the second bracket-side hole and the second capsule-side hole.

6. The supporting apparatus for the steering bracket according to claim 1, wherein a guide surface is provided on the surface of the separation capsule or the steering bracket so as to guide a movement direction of an inertial action body due to action of inertia.

7. A steering apparatus that is supported by the supporting apparatus for the steering bracket according to claim 1.

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